



SkyStopper Equatorial Platform

User Guide

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SkyStopper Equatorial Platform User Guide

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Throughout this publication, the SkyStopper Equatorial Platform is referred to as SkyStopper, for convenience and enhanced readability. Any reference to SkyStopper indicates the SkyStopper™ Equatorial Platform.

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Ekasilicon Technology Ltd
3384 Guildwood Drive
Burlington ON
Canada
L7N 1L5
905 333 6472
smrg@cogeco.ca

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1

Getting Started

1.1 Before You Start

Thank you for purchasing the SkyStopper™ Equatorial Platform (SkyStopper).

When used according to the procedures in this User Guide, SkyStopper will enhance the viewing enjoyment of your Dobsonian telescope safely, without risk of personal injury or equipment damage. Please follow the procedures in this User Guide to operate your SkyStopper.

We recommend that you print this User Guide and take it with you when observing.

Warning Tracking celestial objects requires the platform to tilt the telescope. When a telescope is tilting, there is a danger of it tilting over far enough to fall, resulting in personal injury or equipment damage. Ekasilicon Technology Ltd is not responsible for personal injury or equipment damage due to misuse of SkyStopper.

Tip-Resistance Your SkyStopper has been custom-made for your telescope, based on measurements you provided when ordering. During normal operation, the platform will tilt your telescope up to 8.5 degrees in either direction.

We have analyzed the dimensions and weight of your telescope, and designed the platform to remain within safety margins in all operating conditions.

Any telescope can be blown over in a strong enough wind, regardless of tilt from a platform. However, when the telescope is already partly tilted in high wind conditions, tipping becomes more likely. In windy conditions, consider a sheltered location or restrict the platform to only small tilts near center.

When you first mount your telescope onto SkyStopper, complete the test shown in [“Testing For Tip-Resistance” on page 18](#)

Stability Without the linkage attached, your telescope should not accelerate towards the outer extreme angles. The platform is designed to make the telescope seek the center slightly. For more information, see [“Attaching and Detaching the Magnetic Linkage” on page 15](#).

1.1.1 Using this Guide

Ekasilicon Technology Ltd recommends that you read the required chapters before operating the platform, and read the optional chapters as required:

Number	Title	Status	Condition
1	Getting Started	Required	Before using the first time
2	Pocket Reference	Required	During first use
3	Leveling and Aligning	Optional	At Home and Away From Home operations
4	Controlling SkyStopper	Optional	Before using the first time
5	Operations	Required	Basic procedures and additional commands
6	Troubleshooting	Optional	In case of trouble
7	Glossary	Optional	Terminology questions

1.2 About Controlling the Platform

SkyStopper™ can be controlled from the remote controller or from the single button on the main controller. The functionality of the single button on the main controller duplicates exactly the functionality of **OK** on the remote controller.

The central position of **OK** on the remote makes it easy to locate in the dark, without needing to refocus your eyes from the eyepiece.

The keypad of the remote controller has numerous other buttons, and can be used for functions that are not available from the main controller.

To make operations more comfortable, an optional remote infrared receiver is available, that can be placed in a convenient location to receive commands from the remote controller.

1.2.1 Available Models

SkyStopper is available in two model configurations:

- Triple-axis guiding
- Single-axis guiding

Model differentiators are shown in bold:

Feature	Triple-Axis	Single-Axis
Precise computer-controlled tracking	Y	Y
Pre-set tracking parameters	Y	Y
Accurate over a range of observing latitudes	Y	Y
Smooth tracking for up to 90 minutes	Y	Y
Magnetic linkage easily connects platform and motor	Y	Y
Calibrated bubble level for quick setup at preferred observing latitude	Y	Y
Bubble level can be re-calibrated for alternate observing latitudes	Y	Y
Detailed instructions for setting up at alternate observing latitudes	Y	Y
Three adjustable and lockable platform feet	Y	Y
Remote controller included	Y	Y
Operates with reduced functionality if remote controller is not present	Y	Y
Positive stop at ends of travel	Y	Y
Includes L-blocks for locking in Center position during setup	Y	Y
Audio speaker with seven levels of mute	Y	Y
Dimmable display	Y	Y
Guide port	Y	Y
Note: Single-axis model supports Right-Ascension guiding only		
Remote Infrared Receiver	Y	Y
12V Power Cable	Y	Y
Voltage range: 10.5 - 20 volts	Y	Y
Rapid rewind to Center position	Y	Y
Rapid rewind to Start position	Y	Y
Commence tracking with a single button press	Y	Y

Feature	Triple-Axis	Single-Axis
Seek to absolute position	Y	Y
Easy to pause and resume tracking	Y	Y
Available tracking rates include Star, Solar, Moon	Y	Y
Tracking rate easy to change	Y	Y
Fine-tunable Moon tracking rate	Y	Y
Half-solar tracking rate enables heliostat functionality	Y	Y
Requires matching telescope feet	Y	N
Fine adjustment of eyepiece view in all directions	Y	N
Polar misalignment correction mode	Y	N
Adjustable direction of declination guidance	Y	N
Single button recovery from power failure	Y	Y
Slow and fast adjustment of positioning in right-ascension direction	Y	Y
Integrated audio timer	Y	Y
Full one year warranty	Y	Y
Available spare parts	Y	Y
Available out-of-warranty repairs	Y	Y
Thirty day money-back guarantee	Y	Y

1.3 About Mounting Your Telescope

Mounting your telescope differs slightly between the triple-axis and single-axis SkyStopper models.

1.3.1 Triple-Axis Telescope Mounting

The triple-axis SkyStopper has a guide actuator which lifts or lowers the south foot of the telescope, and can also move it from side to side. The range of motion is approximately 1 degree in each direction, in approximately 0.3 arc-second steps.

Because of this motion, the triple-axis SkyStopper grips the feet of your telescope firmly, to accurately position it for guiding. Each foot of the telescope is gripped differently, according to how it must move:

Foot	Grip
South	Placed into a cone-shaped cup that restricts it from moving laterally unless the actuator controls it
Northwest	Constrained to a line which runs approximately north by northeast. To achieve this alignment, a Teflon-lined channel sits under the foot and constrains it from moving east or west.
Northeast	<p>Holding the previous two feet as indicated above is sufficient to positively locate the telescope, provided the third foot is allowed to move laterally.</p> <p>A Teflon pad enables the third foot to move laterally. The Teflon pad enables tiny motions of the telescope without static friction, which would otherwise cause the telescope to store up tension and advance several steps worth of distance suddenly.</p>

1.3.2 Single-Axis Telescope Mounting

The single-axis SkyStopper does not grip the feet of your telescope. The telescope base sits on the flat surface of the platform.

To achieve optimum balance, position the telescope on the center line of the platform, and adjust towards or away from the apex as required. During construction, a mark is scribed that indicates the ideal position of the center of the telescope turntable. When mounting a different telescope, test the telescope for stability with the linkage removed, then adjust its position north and south for best balance.

The single-axis platform features a large range of adjustment. Be careful that the feet of the telescope do not extend past (or too near to) the edges of the rocker. For telescopes which have a lot of friction when rotating, you might need to apply (supplied) adhesive traction stickers where the telescope feet will sit.

The adhesive traction stickers prevent sliding, which is usually not a problem but could be when rotating the telescope by the optical tube assembly.

1.4 Upgrading Your Telescope Feet

Note: This procedure may or may not be required prior to using SkyStopper. Please read this entire topic first, and determine whether you need to upgrade your telescope feet or not.

If it was determined during manufacturing that your existing telescope feet are incompatible with the SkyStopper design, you must install the supplied telescope feet. In this case, your shipment will include replacement telescope feet, stainless steel screws, and instructions for mounting on a radius circle specific to your telescope, measured relative to the center of the telescope.

If your platform includes telescope feet, you must install them on your telescope base with the included screws, in the locations shown in your Build Sheet.

If your SkyStopper includes new telescope feet, install them by drilling a 1/8" pilot hole, 3/4" deep, in the indicated locations. Use a #8 Robertson or Square Drive screwdriver to install the feet.



Replacement Foot, With Foot Grabber

If SkyStopper can grip the telescope feet you already have, the platform will support those feet, and you do not need to upgrade your telescope feet.

Depending on your telescope, you may also receive wooden Foot Grabbers which positively lock the feet of your telescope in the ideal position. If the Foot Grabbers are used, complete the balance and tip-resistance tests to determine the attachment points which yield optimum stability. Use double-sided tape to adhere the Foot Grabbers to the platform.

Foot Grabbers can be made to fit the feet already on your telescope, if measurements are provided at the time of ordering.

1.5 Setting Up the Telescope and Platform

To mount your telescope on the platform:

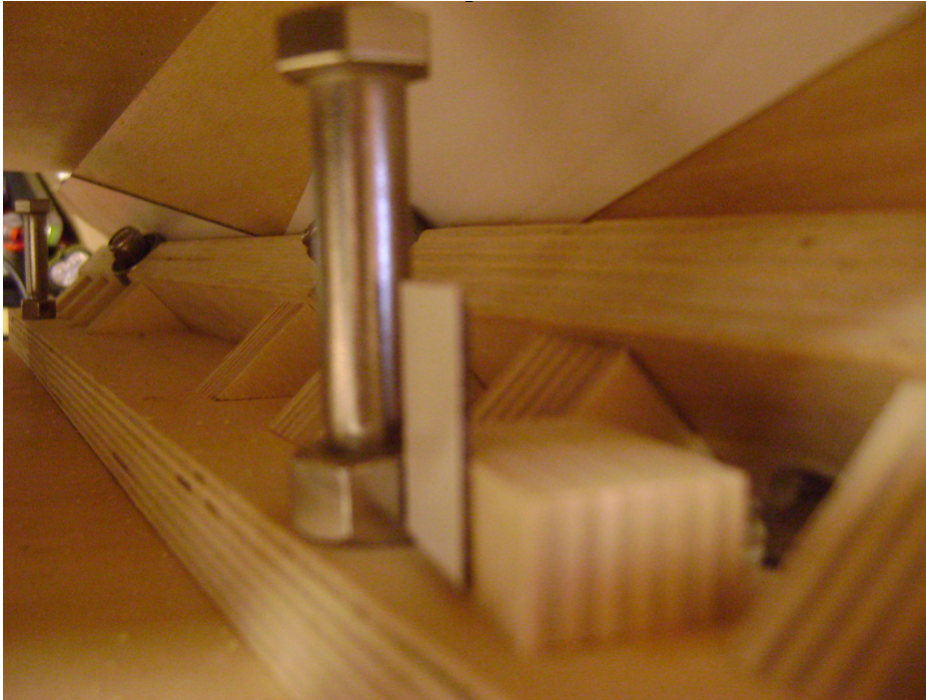
1. Place the SkyStopper base on the ground.
2. Loosen the wing nuts, then level the base using the levelling knobs, as indicated by the bubble level.



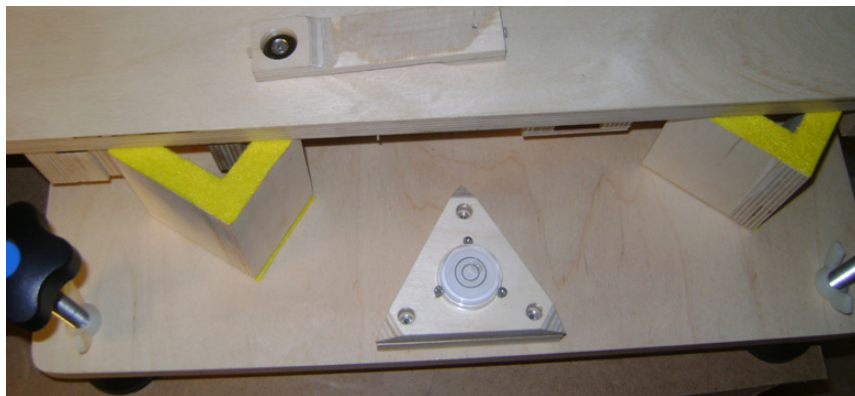
3. Tighten the wing nuts again to lock the feet, preventing them from wobbling.
4. Ensure the linkage is not connected to the base or platform.

5. Mount the SkyStopper platform onto the base.

Positive stop bolts prevent the arcs from falling off the bearings at the end of travel, if the linkage is not connected.



6. Place the L-blocks under the platform to prevent it from moving.



7. Place the base of the telescope on the SkyStopper platform.
8. On the triple-axis platform only, place the south foot of the telescope base into the actuator on the platform.
9. On the triple-axis platform only, lift the northwest foot to allow it to sit in the channel. It may be necessary to lift the entire north end of the base so the northeast foot can sit on the Teflon pad. When the northwest foot is in the channel, the northeast foot will automatically be centered on the Teflon pad.
10. Assemble the components of the optical tube assembly onto the telescope's base.

Avoid dropping heavy items onto the platform with high impact, as it could potentially dent the surface of the arc boards.

11. Complete the assembly of your telescope.
12. Complete any collimation process which does not require star tracking.
13. Remove the L-blocks.
14. Ensure the telescope is stable without the linkage attached.

If this is the first time you have assembled your telescope on to the platform, ensure the telescope is stable without the linkage attached.

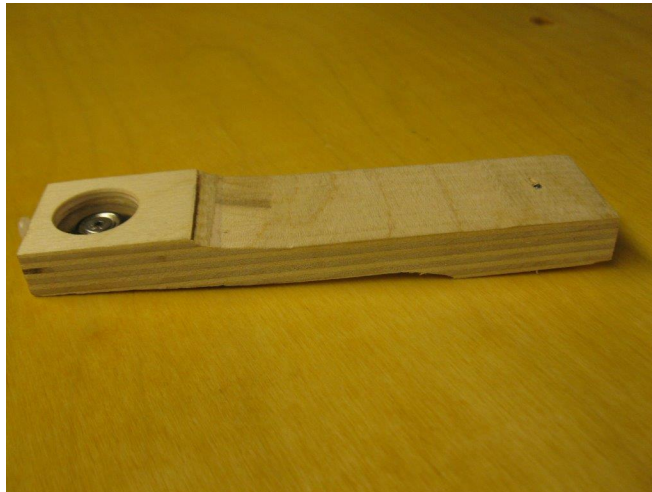
Verify that when the telescope is on the platform, without the linkage attached, the platform can be tilted toward either extreme, and will either balance in the new position or gradually move back towards the Center position.

Maintain a firm grip on the telescope when performing this test, and ensure that the telescope does not accelerate towards the end points.

15. Attach the linkage to the platform and tilt the platform, if necessary, so that the linkage can connect to the base. It will snap into place as the magnets engage.

For more information, see [“Attaching and Detaching the Magnetic Linkage”](#) on page 15.

1.5.1 Attaching and Detaching the Magnetic Linkage



Magnetic Linkage

The SkyStopper base connects to the movable carriage on the platform with a magnetic linkage. The magnets enable the platform to move slowly and accurately, and are designed to release without damage, if force exceeds the amount required to move the platform. The linkage may also disconnect if the telescope is improperly balanced.

The linkage functions include:

- Preventing the carriage from rotating freely on the threaded shaft
- Holding the carriage precisely in the plane of the pedestal
- Transmitting force precisely to the carriage, enabling the rocker to move accurately

The linkage is arranged to be almost parallel to the rod. Consequently, lateral wobble in the rod is cancelled geometrically, and the motion of the platform is determined only by the advancing of the carriage along the rod.



Magnetic Linkage Connected

The linkage has a profile which is thinner than the spacing between the magnets, in case it becomes caught between the pedestal and the carriage. This prevents the weight of the telescope from being exerted laterally on the rod which could bend the rod.

If the platform is assembled and the linkage is not yet attached, a positive stop prevents the platform from coming off the bearings. The positive stop is located just beyond the normal end of travel.

Play in the linkage is adjustable, by tightening the nylon screws on each end:

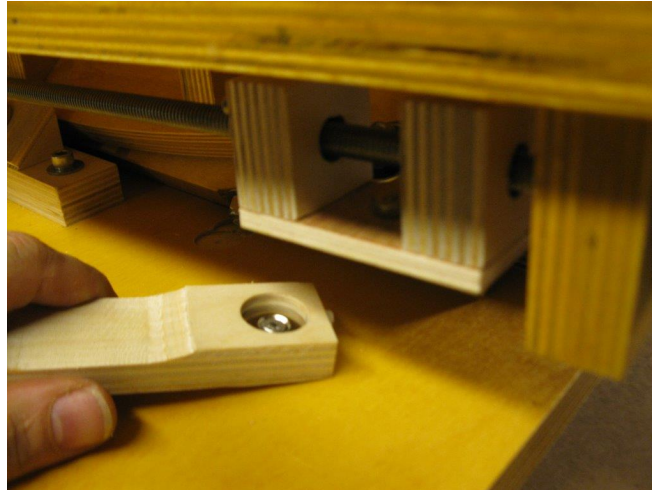


Linkage Play Adjustment

Less than a millimeter of nylon screw should extend past the wood on the inside of the linkage.

The rocker can be lifted off the base without concern for damage to the linkage, carriage or threaded shaft, because the strength of the linkage is tuned to hold firmly, and release if an unusual stress is applied to it.

The linkage is designed to allow connection in low-light observing conditions.



Connecting The Linkage

To connect the linkage:

1. Hold the linkage near the carriage, as shown. The linkage is magnetically attracted to the carriage. If the polarity is wrong and the magnets repel each other, use the other end of the linkage.
2. Tilt the platform until the linkage is near the pedestal.
3. Lift the free end of the linkage inwards slightly towards the threaded rod, and move the free end close to the pedestal.

The far end of the linkage will partly lift from the carriage, but magnetic force maintains the parts in position and ready to re-seat. When the linkage's free end, which you are holding, is close enough to the pedestal, the magnet will pull on the linkage, locking it in place.

A clicking sound is heard as the linkage snaps into position. The magnets are adjusted not to touch. The linkage relies on wood-on-wood friction and alignment.

1.5.2 Preventing Your Telescope From Tipping

Dobsonian telescope mounts typically include a turntable and a rocker. They are designed so that the telescope's center of gravity remains above the center of the turntable, preventing it from tipping over.

SkyStopper was designed and constructed based on the information you provided about your telescope's center of gravity, feet placement, and preferred latitude. The first time the platform is used, carefully ensure that the telescope does not tip at either extreme of travel.

When mounted on SkyStopper, the telescope will typically follow approximately 22 degrees of sky rotation. Only part of the required motion is achieved by tilting the telescope, with the balance of required motion achieved by horizontal rotation of the platform.

SkyStopper is designed to not tilt more than a safe amount, reducing the risk of personal injury or equipment damage.

The required tilt is 22.5 degrees times the cosine of your design latitude, which provides several degrees to east and west. During manufacture, the measurements of your telescope are used to ensure the design will not tilt your telescope too far.

Warning Tracking celestial objects requires the platform to tilt the telescope. When a telescope is tilting, there is a danger of it tilting over far enough to fall, resulting in personal injury or equipment damage. Ekasilicon Technology Ltd is not responsible for personal injury or equipment damage due to misuse of SkyStopper.

When the platform is positioned north or south of the design latitude, an additional tilt in the north or south direction is required to maintain polar alignment.

The feet of the telescope and the feet of the platform must remain beneath the center of gravity of the telescope at all times and in all positions. Travelling northward requires that the south end of the platform must be set lower than at Home. This is the apex end of the triangle formed by the feet of the telescope.

The Center of Gravity is shifted closer to the apex, allowing less lateral tilt before nearing its tipping point.

Travelling southwards makes the telescope less likely to tip, for a few degrees.

Attempting to use the platform many degrees south of the design latitude may result in the telescope being tilted too far north and tipping towards the north. For this reason, a platform designed for northern latitudes will not work at the Winter Star Party.

1.5.3 Testing For Tip-Resistance

To assess the tip-resistance of your telescope when mounted on SkyStopper:

1. Mount your telescope on the platform, then remove the L blocks, but do not attach the linkage.
2. Stand beside the mounted telescope.
3. Move the telescope and platform until the platform is tilted towards you.
4. Be ready to catch your telescope if it starts to tip.
It should not tip, as the platform is designed with an ample safety margin.
5. When the platform reaches the end of its travel and stops, grasp the telescope and pull it gradually towards you, causing it to begin tipping.
6. Note how many inches the telescope must move before it reaches a balance point on just the two feet closest to you.

The measured distance is the tipping safety margin at your design latitude. It must remain positive when the scope is rotated, and in all latitudes when travelling.

The information you received about your SkyStopper will indicate the latitude range over which an adequate safety margin is maintained.

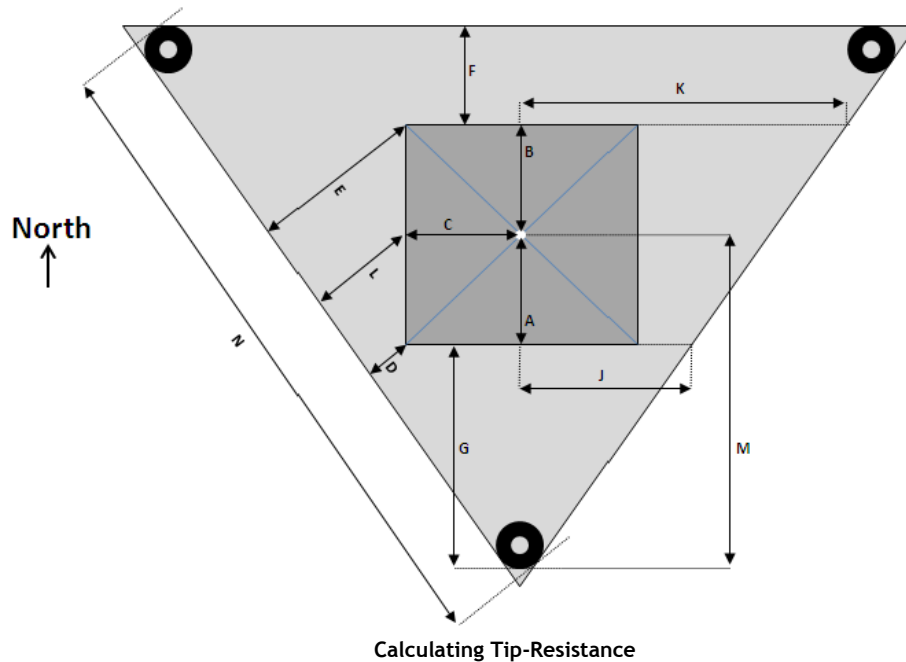
SkyStopper is designed with a minimum of 1.5 inches (37 mm) of safety at the level of the center of gravity (which means, more distance at higher points on the telescope) when used in the design latitude range.

1.5.4 Tip Safety Example

This topic helps to calculate the tip-resistance of your telescope, when mounted on SkyStopper.

This is a sample tip safety margin diagram, showing the distances and considerations. The telescope's center of gravity can move around, above the triangle defined by the telescope feet. In this diagram, the light-shaded triangle represents the three feet of your telescope. The darker-shaded square represents the possible positions of the center of gravity as you track from east to west, depending on your setup at various latitudes.

During tracking, the center of gravity moves along a lateral line in the diagram. The position of that line is determined by your current latitude. The telescope, if it begins to tip, will not tip laterally. It will tip onto two of its three feet. Therefore the tip safety margins are computed in the direction perpendicular to the two closest feet.



This section explores tip-resistance during travel, assuming equilateral placement of feet on the telescope:

- Design duration in minutes (number of minutes from Center to End): 35 minutes
- Design latitude in degrees: 49.73 degrees
- CoG height : 498.22 mm
- Home Latitude: 49.73
- Northward travel: 4 degrees
- Southward travel: 6 degrees

Legend	Description	Value	Measure
A	Southward motion of CoG above triangle due to northward travel	34.84	mm
B	Northward motion of CoG above triangle due to southward travel	52.36	mm
C	Maximum lateral displacement of CoG due to tilting while tracking	49.56	mm
D	Lateral safety margin at northernmost latitude	33.73	mm
E	Lateral safety margin at southernmost latitude	77.33	mm
F	Northward safety margin at south limit	97.75	mm
G	Southward safety margin at north limit	225.16	mm
J	Half width of triangle at northern limit	92.47	mm
K	Half width of triangle at southern limit	142.82	mm

Legend	Description	Value	Measure
L	Tipping safety margin at design latitude	83.65	mm
M	Radius of foot circle on the scope in mm (center to outer edge of foot)	260	mm
N	Assuming an equilateral triangle, this is the edge of the triangle perimeter	450.33	mm

Dimension D is always the determining distance for minimum tip-resistance.

1.5.5 Understanding Your Build Sheet

Your build sheet contains parameters used in its design and construction:

Description	Value	Measure
Height of blocks to hold the platform level during telescope assembly	82.11225	mm
Telescope foot radius, measured from center, based on telescope construction	260	mm
Base length between feet lines measured north to south	809.1466	mm
Nominal height change per turn of main leveling knobs	1.75	mm
Latitude distance per turn, in km	13.75521	km
Latitude distance per turn, in miles	8.547092	miles
Millimeters per minute of arc away from pole laterally	0.556051	mm
Minimum tip-resistance over the range of travel	33.73	mm

Note: The numeric values in the table above are example values from a production SkyStopper. Your Build Sheet will include numbers that are specific to your telescope and location.



2

Pocket Reference

2.1 Setup

Your SkyStopper™ equatorial platform is ready to use, right out of the box. It has been designed to fit your telescope, and calibrated for the preferred observing latitude (Home Latitude) you specified when ordering. For more information on your Home Latitude, see [“Leveling and Aligning” on page 25](#).

To setup SkyStopper for observation:

1. Place the SkyStopper base on the ground.
2. Locate or estimate North.
3. Align the center axis of the base with North, as shown:

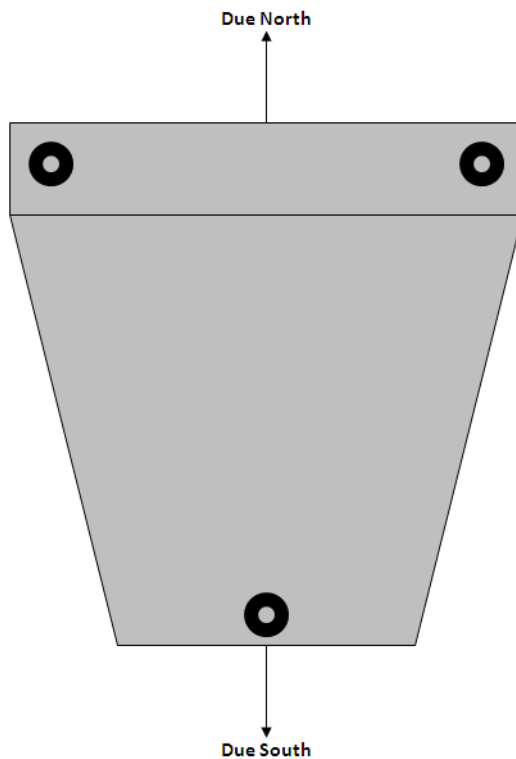


Figure 3: SkyStopper Polar Alignment

4. Loosen the wing nuts on the adjustable legs, and level the platform as indicated by the bubble level.
If you are not at the preferred observing latitude specified when ordering, after levelling with the bubble level, turn the apex screw the required number of turns for your actual position, calculated as:
$$(\text{latitude} - \text{calibrated latitude}) / (\text{degrees per turn}) = \text{turns of the apex screw}$$

If you are north of your preferred latitude, lower the south end of the platform the computed number of turns.
If you are south of your preferred latitude, raise the south end of the platform the computed number of turns.
5. Place the SkyStopper rocker onto the base.
6. Stabilize the rocker with the L-blocks.
7. Place the base of your telescope onto the rocker.
8. If you are using the triple-axis model, lock the feet into place.
9. If you are using the single-axis model, center the base of your telescope on the mark.

10. We recommend that you mark the position of the outer edges of your telescope on the platform once you are satisfied with its location.

For more information, see [Step 14 on page 15](#).

11. Construct and align your telescope as you normally would.

12. If you are setting up your SkyStopper for the first time (only), complete this step:

- Carefully remove the L-blocks.
- Hold your telescope firmly.
- Manually tilt the base left and right.
- Verify that your telescope does not start to tip at any angle.
- Verify that your telescope seeks the Center position when you release your grip.
- Manually tilt the platform all the way to one side.
- Stand on the low side of your telescope, and pull it gently towards you.
- Verify that your telescope does not tip.
Tilt your telescope towards the southeast or southwest to determine the direction that is most likely to tip
- If you are now satisfied that your telescope is safe and will not tip, release the platform and allow it to settle back to the Center position.

If you have set up your SkyStopper previously, resume here:

13. Apply the magnetic linkage to the rocker carriage, as shown in [“Attaching and Detaching the Magnetic Linkage” on page 15](#).

14. Adjust the angle of the platform as required, and connect the linkage to the pedestal on the base.

15. Install the white speaker cable into the socket on the main controller that is designated with a white ring.

Note: The main controller has two sockets. The socket circled with a white ring is for the speaker. The other socket is for an optional IR Remote receiver. The sockets are not interchangeable. Permanent damage will occur if power is present and the speaker is erroneously plugged into the IR Remote socket connector.

16. If you are using the optional remote infrared receiver:

- Plug the cable into the socket on the main controller.
- Position the remote infrared receiver in a convenient location.
- Plug the other end of the cable into the remote infrared receiver.
- If required, use the optional second cable (1 meter) to extend the range of the infrared remote receiver.

17. Provide power to the main controller with the main power cable.

18. The main controller beeps immediately when powered up, and the decimal point in the main controller display illuminates.

19. If the main controller does not power up, check the battery pack and connections.

20. Ensure sufficient clearance for your telescope to move under control of the motor.

If the platform jams, the controller will beep, alerting you to remove power. Ensure that the L-blocks are not interfering and restricting movement of the rocker.

Note: In some conditions, there is potential for motor damage. For more information, see [“Carriage Jamming” on page 66](#).

21. Press **OK**.

The main controller will:

- Beep

- Seek the Index position
- Begin tracking at Star rate
- Display a symbol on the LCD display
- Beep again to indicate the current tracking rate

Your SkyStopper is now calibrated to accurately track celestial objects.

2.1.1 Rewind to the Start Position

When the tracking duration has elapsed (approximately 90 minutes, terminated by reaching the End position), the platform stops and the main controller beeps for five seconds.

- To rewind to the Start position, press **OK** for one second.
- To resume tracking once rewinding is complete, press **OK** for less than one second.

2.1.2 What To Do Next

Now that SkyStopper's basic setup and operations are complete, you can track celestial objects. For details and specific procedures, see "[Operations](#)" on [page 51](#) of the *SkyStopper Equatorial Platform User Guide*.



3

Leveling and Aligning

3.1 Using SkyStopper At Home

To make accurate setup of your SkyStopper platform quick and easy, each unit is calibrated for the observing latitude you specified when ordering. For convenience in SkyStopper technical documentation, the original design latitude your of unit is referred to as your Home location.

To enable you to use SkyStopper within a reasonably wide range of latitude from your specified Home location, it has a design tolerance of $\pm x$ degrees. Within this specified range of latitude, the platform will be accurate when setup using its Home calibration. When observing from Home, no adjustments to the bubble level are required. In this case, see:

- [“Leveling At Home” on page 26](#)
- [“Observing From Home” on page 26.](#)

For convenience in SkyStopper technical documentation, any location beyond the specified latitude tolerance is referred to as Away From Home. To maintain accurate tracking when observing Away From Home, adjustments to the setup procedure are required. In this case, see [“Leveling Away From Home” on page 27.](#)

3.1.1 Leveling At Home

When observing from Home, no latitude compensation is required. SkyStopper has three knobs that operate the leveling feet, and each foot has a wing nut that locks the foot in place.

To level SkyStopper at Home:

1. Position the platform base on the ground, aligned to true north.
2. Loosen the wing nuts on each leveling foot.
3. Adjust the knobs until the bubble level is centered.
4. Gently tighten each wing nut without rotating the foot.
The platform is now leveled for Home.

Note: If the ground is soft, mount the telescope onto the platform first, to compress the ground under the feet before leveling, so that it will not sag afterwards.

On soft ground, you can distribute the weight by positioning a larger object (a piece of wood or a flat rock) under each foot before leveling.

3.1.2 Observing From Home

To use SkyStopper when the bubble level is calibrated for Home:

1. Level the platform as shown in [“Leveling At Home” on page 26.](#)
2. Install the rocker platform and L-blocks.
3. Mount your telescope onto the platform.
4. Remove the L-blocks.
5. Install the linkage.

The platform and telescope are now ready to accurately track celestial objects. For specific procedures, see [“Operations” on page 51](#), [“Controlling SkyStopper” on page 31](#), and [“Advanced Functions” on page 57.](#)

3.2 Using SkyStopper Away From Home

For best results, SkyStopper's axis must be pointed at the same altitude as the celestial pole. Although a reasonable amount of tolerance is allowed in the design, 1/5 of a turn of the levelling feet corresponds to just a few km (or miles) and therefore when not at your Home latitude, you should compensate after levelling according to the bubble level.

Whenever your current observing latitude exceeds the tolerance specified in [“Using SkyStopper At Home” on page 26](#), you must compensate for the difference in latitude as specified in [“Leveling Away From Home” on page 27](#).

3.2.1 Compensating For Being Away From Home

To compute the number of turns to compensate for latitude:

1. Determine the latitude of Home and your current Away From Home locations.
2. Calculate the latitude difference between Home and Away From Home.
3. Calculate the number of turns:

The actual figure will be on your build sheet, as well as some precompensated turns counts for locations you provided. The function is not linear, so for large amounts of travel, calculate:

$$\text{<number of turns>} = \tan(\text{latitude difference in degrees}) * (\text{feet separation from build sheet}) / 1.75 \text{ mm}$$

4. Adjust the legs as required, see [“Leveling Away From Home” on page 27](#).

For information about leveling precision, see [“About Leveling Precision” on page 29](#).

3.2.2 Leveling Away From Home

SkyStopper has three feet, each with a significant amount of travel. By setting all feet at an approximately equal height and adjusting the apex foot, you can very effectively compensate for observing Away From Home.

Leveling At More Polar Latitudes

To level SkyStopper at a more polar latitude:

1. Set all feet high.
2. Level SkyStopper according to the bubble level, as described in [“Leveling At Home” on page 26](#).
3. Lower the apex foot the number of turns computed in [“Compensating For Being Away From Home” on page 27](#).

Leveling At More Equatorial Latitudes

To level SkyStopper at a more equatorial latitude:

1. Set all feet low.
2. Level SkyStopper according to the bubble level, as described in [“Leveling At Home” on page 26](#).

3. Raise the apex foot the number of turns computed in [“Compensating For Being Away From Home”](#) on [page 27](#).

If You Need More Height

You might run out of adjustable turns if SkyStopper is being used on uneven ground, away from your Home Latitude.

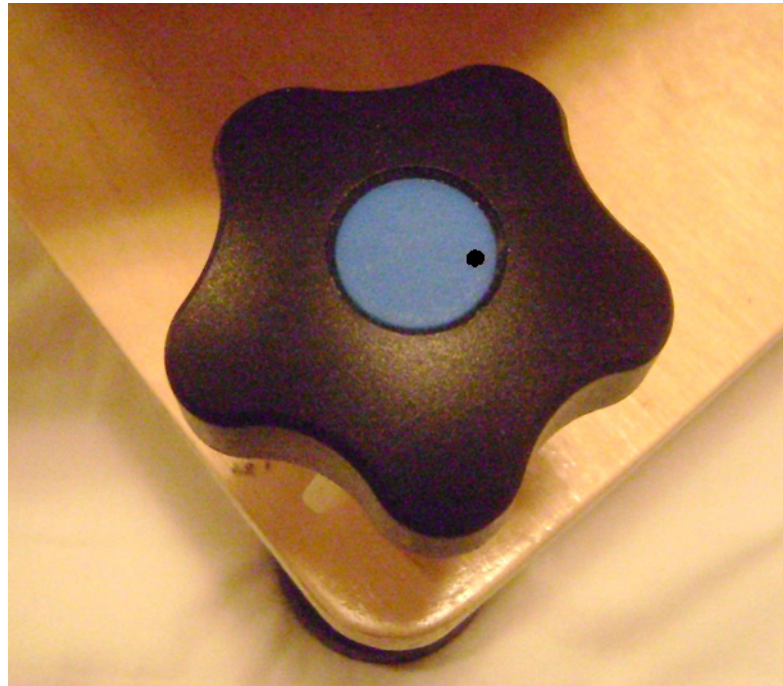
In this case, pre-compensate the feet by raising the south foot (if travelling south) or the north feet (if travelling north), with some blocks of wood, before levelling it. Then you will be able to apply the appropriate number of turns to compensate for the difference in latitude.

Remember that opposite direction turns on the opposite feet are just as effective. For safety, do not disassemble the knobs from the feet.

3.3 About Leveling Precision

When calculating a latitude compensation factor, the adjustments can be very precise, for example, 2.14 turns of the knob. In most cases, adjusting to the nearest 0.1 turn is sufficiently accurate resolution.

Each knob has an indicator marked on it, to assist when making full turns (in this example, two full turns). The handle of the knob features a five-fluted profile, each of which corresponds to 0.2 turns.



Five-Fluted Knob Design

Each 0.1 turn inaccuracy introduces less than one minute of arc misalignment. For astro-photography applications, use your guide software to correct for this.

For example, at the eyepiece, the Ring Nebula, which is about 1.4 arc-minutes in diameter, even at very high magnification, will only shift by 1/4 of its diameter in 90 minutes.

3.4 Aligning Laterally on the Celestial Pole

At least one star, near the meridian, near the celestial equator, must be visible to complete this procedure. If SkyStopper is laterally misaligned on the pole, you will see a gradual drift of the stars in the eyepiece.

SkyStopper remembers the amount of motion required to keep a star centered in the viewer. In conjunction with the configured calibration of motion, and the factory supplied distance over which the motion acts (the distance between the feet of your telescope), the platform reports the angular drift of the star in arc-seconds per 240 seconds of time, which can be directly translated into arc-minutes east (if the star moved north) or west (if the star moved south) of the celestial pole.

Use this procedure to quantify that drift, and then apply a one-step correction to align SkyStopper accurately.

To laterally align on the Celestial Pole:

1. Select a visible star within 10 degrees of the meridian, at an altitude that puts it near the celestial equator (90 degrees minus your current latitude).

For example, use a star near the zenith if you are at the equator.

2. Set up the platform normally, as indicated by the bubble level.
3. Compensate for any difference in latitude.
4. Centre the star in the eyepiece.
5. Press the **Green** button on the remote controller.
6. Using the fine centering controls, adjust the platform so that the star remains in the center of the viewer.
7. After at least one minute, when the star is again centered in the eyepiece, press the **Green** button again.
8. Press **6, <-PR, Blue**.

The display will cycle through the digits of the correction factor. for instance it might show:

836 836 836

In this example:

- The telescope is aimed 8.36 minutes of arc left of the celestial pole
 - Look up the number of mm per minute of arc to move the platform, and multiply by 8.36.
 - Move the base of the telescope over by that number of mm.
9. Adjust the lateral position of the platform by the number of mm indicated on your build sheet, for good polar alignment.
 10. Cancel the correction factor that was initiated with the **Green** button, by holding the **Blue** button for five seconds.



4

Controlling SkyStopper

4.1 Operating From The Main Controller

The main controller has a single control button available from the chassis:



Main Controller

Number	Description
1	Internal infrared receiver
2	Main Power connector <ul style="list-style-type: none">• Supply Voltage 12 - 20VDC, center positive• Single Axis SkyStopper: 200 mA minimum• Triple Axis SkyStopper: 600 mA minimum• Use dedicated +12 VDC power pack or power tank
3	Control button
4	Programming port, factory use only
5	ST-4 guide port

Number	Description
6	Optional speaker jack, 1/8 stereo mini-jack
7	Optional remote infrared receiver jack
8	LED display

Depending on what SkyStopper is doing, the control button has different effects. The operating mode provides context for commands issued with the control button.

Depending on the current operating mode, short, medium, and long presses on the main controller's button have different effects.

The main controller responds to control input durations including:

- **Short Press:** Less than one second
- **Medium Press:** Longer than one second, less than four seconds
Action commences when the button is released
- **Long Press:** Longer than four seconds
Action commences after four seconds, regardless of when the button is released

Commands are issued according to the following table:

Mode	Button Press	Action In Progress
Idle	Short	Initiates tracking
	Medium	If the carriage is at the Start position, moves the carriage to the Center position Otherwise, moves the carriage to the Start position
	Long	Finds the Index position
Tracking	Short	Pause
	Medium	Steps through available speeds: <ul style="list-style-type: none"> • Sidereal • Solar • Lunar • Half-solar
	Long	Rewinds to center position
Rewind	Short	Steps through available destinations: <ul style="list-style-type: none"> • Center • Start • End <p>Uses controlled acceleration and deceleration so that calibration is maintained</p>
	Medium	Stops the rewind at the current location
	Long	Stops the rewind Returns the carriage to the position it was before the rewind commenced Compensates position to account for time lost in transit

Mode	Button Press	Action In Progress
Find Index	Short	Cancel
	Medium	Cancels the Find Index operation Leaves the carriage at a known position, relative to where the operation was initiated
	Long	Cancels the Find Index operation Returns the carriage to its previous position, if possible

4.2 Operating From the Remote Controller

The basic functions that can be controlled remotely include:










- Emulate guide inputs
- Increase or decrease the speed of RA tracking
- Move the telescope in the declination direction
- Operate the guide actuator motors individually
- Seek to position
- Single step the most recently commanded motor
- Mute the speaker










SkyStopper™ Remote Controller

4.2.1 Remote Controller Functionality

The remote controller provides the functions shown:

Button Name	Graphic	Description
OK		Emulates the functionality of the single control button on the main controller.
Triangle -		While tracking, slow the tracking speed by 25% while stopped, slew the platform at top speed, eastwards
Triangle +		While tracking, accelerate the tracking speed by 25 % While stopped, slew the platform at top speed, westwards
MENU		Operate the lateral control of the guide actuator, adjusting the telescope pointing counterclockwise in azimuth
FAV		Operate the lateral control of the guide actuator, adjusting the telescope pointing clockwise in azimuth
PR -		Simulate guide input from a guide scope, adjusting the declination axis southward
PR +		Simulate guide input from a guide scope, adjusting the declination axis northward
INFO		Operate the vertical control of the guide actuator, adjusting the pointing of the telescope southward (lower the south foot)
EXIT		Operate the vertical control of the guide actuator, adjusting the pointing of the telescope northward (raise the south foot)

Button Name	Graphic	Description
Red		<p>With a number supplied, set the percentage of lateral motion for the declination axis</p> <p>Without a number specified, toggle the application of the wobble correction settings, to see their effect on tracking</p>
Green		<p>With a number specified, ??????????</p> <p>Without a number specified, begin or end learning a new tracking rate</p>
Yellow		<p>Undo</p> <p>Undo the most recent command that changed tracking (you can undo a pause, a slew, or a reset)</p> <p>The yellow button can also undo a power cycle.</p> <p>Tripping over the line cord is inconvenient. Fortunately the yellow button can help.</p> <p>If you unplug SkyStopper, plug it back in and press Yellow as the first button.</p> <p>It will seek zero, then go back to where it was before seeking zero, and apply a time correction and then re-apply any previously learned tuning factors. SkyStopper does not actually compensate for the time it spent switched off but it does compensate for the time it spent recovering.</p>
Blue		<p>Short press: shows status</p> <p>with a number supplied, show particular status</p> <p>6 is for seeing the lateral misalignment implied by the use of Green on a triple-axis SkyStopper</p> <p>Long press: erase any standing gradual guidance factors</p>
Double Up Arrow		<p>With a number supplied: move the most recently slewed axis by that many steps</p> <p>Without a number specified: move the most recently slewed axis by a single step (useful for calibration)</p>
Double Down Arrow		See Double Up Arrow
Blank Buttons		<p>The remote controller includes three blank buttons.</p> <p>No function assigned: Do not use</p>

Button Name	Graphic	Description
SAT		<p>Toggle the high speed slew correction mode</p> <p>In high speed mode, the operation of the position adjustment controls makes a longer beep, and the platform moves about twenty times faster.</p> <p>In programming mode, this button is used to command new values for SkyStopper physical dimensions. Use of that mode should only be in cooperation with the manufacturer, as it is not documented here.</p>
Four Boxes		<p>This control activates a timebase. SkyStopper will beep every two seconds. Useful for timing transists.</p>
Red Power		<p>Terminate any action in progress, especially runaway motor conditions or if you are seeking zero but forgot to attach the linkage</p>
Mute		<p>There are eight preset mute levels. Pressing the button increments the mute level and shows the new value on the display.</p> <p>0 is most permissive, and 7 is the quietest. SkyStopper will only beep for user input errors when set to 7.</p> <p>For more information on mute settings, see “Speaker Muting Levels” on page 42.</p>
PAUSE		<p>Pauses SkyStopper tracking. This command can be undone with the yellow button.</p> <p>When held for five seconds or more, this initiates an indexing operation on the guide actuator, which takes several minutes to complete.</p> <p>When idle, pressing Pause causes the display to show the currently entered numeric parameters, so you can double check them before issuing a command.</p>
TV / RADIO		<p>Pressing TV / RADIO when entering a numeric value specifies that the number entered is a negative number. Pressing TV / RADIO a second time when entering a numeric value toggles the sign back to a positive number.</p>
<-PR (Enter)		<p>Pressing Enter concludes the number keys and sign which have been input, and pushes them onto the argument stack.</p> <p>Argument stack capacity is four arguments. Some commands require arguments which have been put onto the stack.</p>

4.3 Emulating Guide Inputs

When the carriage is tracking in Lunar speed mode, adjusting Right Ascension tracking using the Green button precisely adjusts the tracking rate of each step, effectively compensating for the moon's path.

You can send an input signal to the guide pathway using the IR remote control. Pressing the remote button simulates a 0.10 second pulse on the guide input. Holding the button strings these pulses together, approximately ten times per second.

The guide port responds to various inputs, including Faster, Slower, Up, and Down. The precision alignment of SkyStopper requires only short amounts of guide signals for astro-photography. For more information on the IR remote control button assignments, see “Remote Controller Functionality” on page 35.

For more information on Auto-guiding, see: www.wikipedia.org/wiki/Autoguider

4.3.1 Adjusting the Tracking Speed

Applying a Moon Tune

You can adjust the Right Ascension tracking rate to compensate for the difference between the moon's apparent rate and its average rate, relative to the stars.

This is called the Moon Tune mode. It is achieved by changing a global multiplication factor on the tracking speed, and is independent of any guide inputs applied later. It is only used in Lunar rate.

To apply a Moon Tune:

1. Center an item on the moon, in the eyepiece.
2. Press **Green**.
3. Adjust the tracking speed:
 - Press **Volume Up (Triangle+)** to increase the RA tracking speed
 - Press **Volume Down (Triangle-)** to decrease the RA tracking speed
4. Wait one minute, and when the crater is centered again, press **Green** again.

The controller will compute the net effect of the guiding commands, and take into account the time between the two times the crater was indicated as being centered, and adjust the platform tracking speed to compensate.

This tuning can be repeated at any time and will work relative to whatever tuning is already being applied.

Discarding the Moon Tune

To totally discard the Moon Tune:

- Press and hold **Blue** for five seconds, while tracking in Lunar mode.

The main controller beeps to acknowledge the cancellation of the speed adjustment.

If you change to sidereal or solar speed, for a period of time, the moon tune speed will not be applied. When you return to Lunar rate to see the moon again, SkyStopper uses the previously set tuning again.

Compensating For Further Residual Drift

If you detect more residual drift than can be detected in the one minute window used in setting the Moon Tune, you can fine tune the tracking even more, effectively compensating for tiny amounts of drift.

To compensate for further residual drift:

1. Set the Moon Tune, as shown in [“Applying a Moon Tune” on page 39](#).
2. Press **Green** a third time.
3. Over the next few minutes, make any gradual centering adjustments required to remain focused on a lunar feature.
4. Press **Green** a fourth time to commit the compensation.

If you press **Green** again without making any intervening adjustments, the Lunar tracking rate remains unchanged.

While in Green tuning mode, SkyStopper beeps once every 20 seconds to remind you that your adjustments will be remembered and used.

To discard Green tuning in progress, press **Pause**. After resuming tracking, SkyStopper will not be in tuning mode.

Previously set committed tuning will still be remembered when tracking is resumed.

To cancel all committed rate tuning, press and hold Blue for 6 seconds.

4.4 Using the Options

SkyStopper supports optional devices that enhance its operation and functionality. The available options include:

- Remote Infrared Receiver
- Speaker

Note: The main controller has two sockets. The socket circled with a white ring is for the speaker. The other socket is for an optional IR Remote receiver. The sockets are not interchangeable. Permanent damage will occur if power is present and the speaker is erroneously plugged into the IR Remote socket connector.

4.4.1 Using the Optional Remote Infrared Receiver

In some cases, placement of the telescope can interrupt reception between the infrared remote controller and the main controller. If telescope placement causes a loss of reception, consider using the optional remote infrared receiver.

The remote infrared receiver plugs into the main controller, enabling you to position it either nearby the telescope, or on the ground.



Optional Remote Infrared Receiver

For more information on which jack to connect to, see [“Operating From The Main Controller”](#) on page 32.

4.4.2 Using the Optional Speaker

SkyStopper is designed to work in the dark, and to operate intuitively without having to refocus your eyes from observing through the eyepiece of your telescope to SkyStopper's controls. The speaker provides an audio confirmation of commands received, enabling you to confidently control SkyStopper in the dark, from the eyepiece, without having to visually check the display. The speaker can be electronically muted, to maintain quiet in the environment.

The speaker has a particular error sound which indicates a weak or garbled infra-red command was received. In that case, aim the remote control directly at the infrared receiver, and repeat the missing command. The error is disregarded, and there is no loss of context.

For more information on which jack to connect to, see [“Operating From The Main Controller”](#) on page 32.

To mute the speaker output:

- Press **Mute** (upper right on the remote controller) repeatedly.
You will hear the beep acknowledgement change. In Mute Level 5 and 6 there is no acknowledgement of the beeps.

The error signal tone triple has a high priority and is only heard in response to:

- Garbled input from the remote controller
- A correctly received command that is impossible to execute
- Problems with the motors or sensors

Because of its high priority, the error signal will always be heard, regardless of the mute level.

To re-engage the speaker output:

- Press **Mute** until the speaker cycles back to Level 0.

4.4.3 Speaker Muting Levels

SkyStopper has eight levels of mute, becoming progressively quieter, including:

Mute Level	Description
0	Default level, all sounds are enabled
1	Eliminates the ticking sound when a button is held and the phase beep which happens each time the drive rod rotates a full turn (once per 30 seconds)
2	Eliminates the beeping sound when a button is first pressed and the command is properly recognized
3	Eliminates the beeping sound for basic functions (centering)
4	Eliminates the beeping sound when travel limit is reached
5	Eliminates all sounds except command acknowledgements and error sounds
6	Eliminates all sounds except acknowledgements of advanced commands
7	Eliminates all sounds except error sounds



Optional Speaker

4.5 Moving The Telescope In The Declination Direction

To move the telescope in the declination direction:

1. Move the telescope as required:
 - Press **PR+** to move the telescope northward
 - Press **PR-** to move the telescope southward
2. Enter a number between 0 - 100.
3. Press **PR-**.
4. Press the **Red** button (speaker LR) to specify a percentage of lateral motion associated with declination motions.

Note: Depending on the direction in the sky that the telescope is pointed, a mixed declination figure might result in northward motion for **PR-** or for **PR+**. Guide software can compensate for this.

For instance, if your telescope is pointing due east, you would set the declination to 100 percent lateral. Then **PR+** will move the view north and **PR-** will move the view south.

If you reposition your telescope to due west, the same 100 percent lateral results in the opposite motion of the telescope when **PR+** and **PR-** are used. For west, use -100 percent lateral.

For this reason, the percentage lateral ranges from -100 to +100

4.6 Activating The Guide Motors Manually

Four buttons around the periphery of the navigation buttons on the remote control manually activate the guide motors:



Guide Controllers

Each time you press the button, the main controller moves the associated stepper motor at its full speed, for 0.1 seconds. If you hold the button down continuously, the motor continues moving until you release the button. By default, the buttons activate the guide motors as indicated:

Button	Motor Activation	Motor Control
FAV	Tracks towards the Index position	0.1 seconds or continuous
MENU	Tracks away from the Index position	0.1 seconds or continuous
INFO	Lowers the apex (south) end of the platform (rotates southward)	0.1 seconds or continuous
EXIT	Raises the apex (south) end of the platform (rotates southward)	0.1 seconds or continuous

SkyStopper's guide actuator can change the orientation of the telescope by approximately ± 1 degree laterally, vertically, or any combination of the two directions.

The Guide actuator consists of a hinged paddle which can be moved up and down by a bearing that rides a movable ramp:

- Motor A moves the ramp under the bearing, causing the paddle to raise and lower.
- Motor B moves the paddle itself laterally.

During tracking operations, the motors move the telescope by the same lateral amount as an azimuth rotation.

This motion causes the bearing to move up or down along the ramp, and the controller moves the ramp at exactly the same rate to achieve a pure lateral motion.

SkyStopper can be configured to respond to the Declination guide inputs by doing a combination of lateral and vertical motion, so that the resulting change in the field of view is perpendicular to the Right Ascension direction. This has two benefits:

- The guide inputs are economical, only commanding the declination motors when needed.
- The guide adjustment is achieved without causing a rotation of the field of view.

If the declination ratio is not properly set, then the response of SkyStopper would be similar to a dual axis platform.

As the guide system attempts to move the image perpendicular to the right ascension, it would actually move at an angle such that compensation in right ascension will also be needed to keep the guide star centered. This compensation causes a tiny rotation of the field of view.

4.6.1 Fine Motor Control

The Double Arrow buttons provide fine motor control, which allows precise motion of the most recently slewed motor, by a user-specified number of steps. This function is useful during calibration and evaluation.

The motor that will be activated is the one most recently slewed:

- Lateral motion if FAV/MENU was most recently slewed
- Vertical motion if INFO/EXIT was most recently slewed
- Right Ascension direction if Triangle- or Triangle+ was most recently slewed

To use fine motor control:

1. Specify a number of steps for the accelerator function on the numeric keypad of the remote controller.
2. Press PR- to register the value.
3. Activate the most recently slewed motor by pressing Double Up Arrow or Double Down Arrow buttons.

The number of steps is retained in memory, and can be re-used by pressing the button again.

Fine motor control provides precise motion according to the user input, therefore the Continuous mode is not implemented for the Double Up Arrow or Double Down Arrow keys.

4.7 Seeking To Position

When the carriage is not tracking, you can command it to move to any position relative to the current position, or to an absolute position.

To seek a relative position:

1. Enter a number.
2. Press the required direction button.
Triangle- and **Triangle+**, located to the left and right of **OK** on the remote controller.

The total travel is listed on your build sheet. It is usually about 500000 ticks.

For example, to track 10000 ticks ahead of a celestial object, press **10000: Enter**, then **Triangle+**.

This parameter applies only once. After the first press, the **Triangle+** button reverts to its original continuous jog mode.

4.7.1 Jog To Position

To repeatedly move 10,000 tick jogs:

1. Press **Triangle+** or **Triangle-** to indicate which motor to adjust
2. Type the number
3. Press **Enter**
4. Use the **Double Up** and **Double Down Arrow** buttons at lower left to get a large jog for each press.

Repeated pressing will jog another 10000 steps.

The motor moves 3575 steps per full turn, and there are about 150 turns of total travel.

4.7.2 Seek To Absolute Position

Pressing **TV / RADIO** when entering a numeric value specifies that the number entered is a negative number. Pressing **TV / RADIO** a second time when entering a numeric value toggles the \pm indicator back to a positive number.

When seeking position, negative numbers are not accepted as normal input for a relative move, so negative numbers are interpreted as absolute position co-ordinates.

Absolute positions are specified numerically, between 0 - 600000, the main controller automatically determines the motion required to seek the indicated position.

To seek an absolute position:

1. Enter a number between 0 and 600000.
2. Press **Minus**.
3. Press **<-PR**.
<-PR is located to the right of 0 on the remote controller.

4. Press either **Triangle+** or **Triangle-**.

Because the platform is moving to an absolute position, the main controller determines the direction it needs to move, based on the current location. In this case, pressing either Triangle+ or Triangle- elicits the same response.

4.8 Displaying Status

At any time during SkyStopper operations, you can display the status of polar alignment correction or the numeric position of the main drive motor.

To show status during tracking operations:

- Press **Blue** to display the amount of guiding for polar alignment correction

Pressing **Blue** displays the number of arcminutes of polar misalignment inferred from the most recent use of **Green** to center a star. This value is measured in units of arcseconds per 240 seconds.

Use this number and the dimensions of your SkyStopper to make a single-step correction to the lateral alignment on the pole. Coupled with the bubble level, this will align the platform accurately on the pole.

Near the meridian, the tracking adjustments for polar misalignment are entirely azimuth. To achieve polar alignment in altitude, use a star near the horizon, due east or west. The lateral actuator indicates the amount of altitude misalignment of the polar axis.

To observe anywhere but the meridian, also cancel the rate adjustment.

- Press **Blue > 2** to display the current numeric position of the main drive motor

Holding **Blue** cancels the effect of rate changes learned when using **Green**. If you adjust the polar alignment, you should first cancel this rate.

There is a scale factor which is used to take into account the dimensions of your telescope and the action of the guide actuator. This factor is calculated at the factory, accurately tuned so that the number of arcminutes is correct.

Pressing **Up Arrow** and **Down Arrow** while showing status causes the current item to step to the next or previous item, and to circulate continuously. Pressing **Blue** again cancels the circulation and stops the status display.



5

Operations

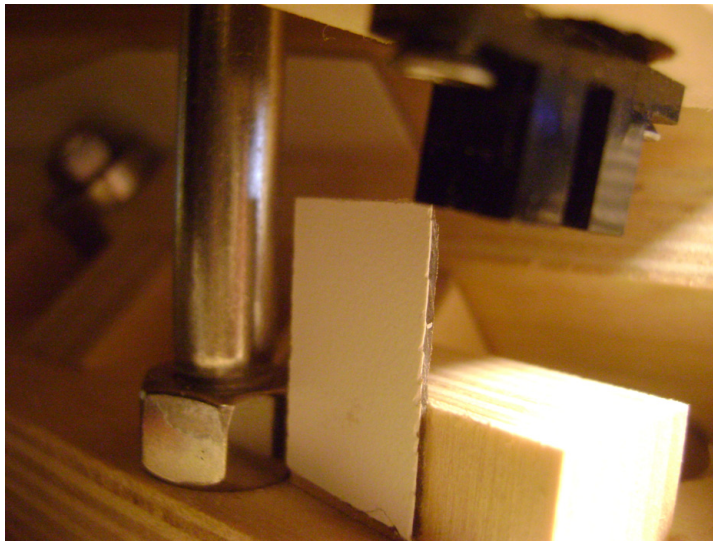
5.1 Basic Functions

Basic functions are available from both the control button on the main controller and the OK button on the remote controller. Each function has a unique beep-sequence to acknowledge the command.

5.1.1 Indexing the Platform

SkyStopper must find the Index position before it can accurately track celestial objects. If you initiate tracking when the Index position remains undiscovered in the current power cycle, the main controller is unaware of the absolute position of the motor, and begins this procedure.

SkyStopper includes a limit switch which precisely indexes its position at the eastward end of travel. Once indexed (in each power cycle), SkyStopper counts motor motion from the Index position to determine the correct tracking rate at all other positions while tracking.



Limit Switch

Use this procedure when:

- Powering up the unit, before tracking celestial objects
- Power has been interrupted
- The linkage has been disconnected for a period of time and the carriage has rotated around the shaft one or more times

To index the platform:

1. If the platform is currently tracking celestial objects, press **Pause**.

Seeking or re-seeking the Index position is only available from the Pause or Stopped states.

2. Press and hold **OK** on the remote controller (or the single button on the main controller) for five seconds, until SkyStopper emits a tone sequence and the motor begins moving toward the Index position.

When the carriage approaches the Index position, the motor will slow down. When the platform position triggers the Start limit switch, the motor stops moving and the platform's absolute position is known.

The zero position is just beyond the limit switch.

If Errors Are Encountered

If errors are encountered while seeking the Index Position, such as an obstruction impeding the progress of the motor, or if the linkage is not connected:

1. Stop the procedure immediately.
2. Identify the cause of the error.
3. Resolve the error before initiating this procedure again.

Note: Damage to the motor gears may occur if seeking the Index position when an obstruction is impeding the progress of the motor, or if the linkage is not connected correctly. If damage occurs, contact the factory for a replacement motor.

Stopping the Procedure

Use either method to stop this procedure:

- Press **OK**.
- Press **Power** on the remote.
- Press the button on the main controller.
- Disconnect the power source.

5.1.2 Seeking the Start/Center/End Positions

After finding the Index position, the SkyStopper can then seek three specific destinations without specifying additional parameters, including:

- Start (in the northern hemisphere, platform leaning eastwards)
- Center
- End (platform leaning westwards)

The platform will return to a set position with sub arcsecond precision. This is a useful function if you want to judge the amount of horizon available from an observing location, or to use digital setting circles which lack a platform mode. You can then use the setting circles and resume tracking.

The platform will not respond to Seek Start/Center/End commands until it has first found the Index position.

Note: For customers in the southern hemisphere, the limit switch is unchanged, meaning at the westward end. The platform will automatically compensate for this when the main controller is initializing.

5.1.3 Setting Tracking On or Off

This procedure requires that the platform has been indexed in the current power cycle, and it knows its current location.

To toggle between tracking celestial objects and pausing:

- Press **OK** for a short tap. A second short tap on **OK** resumes tracking.
- Press **Pause** to stop tracking.

To resume tracking from the Pause state, press **Yellow** to undo the pause. SkyStopper then advances quickly to resume tracking in the location it would have been had it not paused, compensating for any time lost.

5.1.4 Selecting the Display Status: Blue Button

The main controller can display various status items. Commonly accessed status items include:

- **2**: Numeric position of the Right Ascension
- **6**: Gradual guiding rate in arcseconds per four minutes
- All other numbers are used during manufacturing only

To select the display status:

1. Press the number that corresponds to your selection.
2. Press **Enter**.



3. Press **Blue**.

5.1.5 Adjusting the Display Brightness

The display brightness of the SkyStopper is adjustable to suit the current light conditions of your viewing location:

- For viewing in daylight conditions, the brightness can be increased to four times brighter than the default setting
- For viewing at night, the brightness can be decreased to 16 times dimmer than the default setting

The main controller beeps to indicate when the display brightness is changing. Two equal tones indicates that the display is at its limit.

To adjust the display brightness:

- Press and hold **Zero** for > 10 seconds

The display brightness setting continuously cycles brighter then dimmer then brighter, as you hold the button. Keep holding **Zero** and release it when the display brightness is acceptable.

5.1.6 Selecting the Tracking Rate: OK Button

The Moon's rate of travel in the sky relative to the stars, varies from its average during the month by ± 12 percent. The moon travels approximately one degree in the time the SkyStopper can complete one tracking cycle (90 minutes). At the end of the 90 minute cycle, the Moon Rate may vary by as much as ± 5 minutes of arc, compared to the stars.

When the platform is tracking at the Moon Rate, you can the adjust speed by the Moon Tune factor. All steps taken by SkyStopper will be scaled appropriately. In all other modes, you do not need to adjust the tracking rate, unless the platform is not properly aligned.

In case of misalignment, you can set gradual guiding to be synthetically generated within the main controller. It will only be effective in the general direction the telescope was pointing when guiding was set, however it will keep an object visible in the eyepiece for an extended period.

Available Tracking Rates

SkyStopper cycles through the four available rates in sequence, emitting a unique audio sequence for each rate and displaying the corresponding symbol in the display on the main controller, as shown in the table. If the speaker is muted, the audio sequence will not be heard. The available tracking rates include:

Rate	Display Symbol	Audio Sequence
Sidereal (default)	t	Starry Starry Night
Moon	c	Moon River
Solar	o	Here comes the Sun
Half-solar	"	Cryptic

To select the tracking rate:

1. Begin tracking the sky.
2. Press **OK** for one second.

Each time you press **OK**, SkyStopper advances to the next pre-defined tracking rate, as shown in the table.

5.1.7 Adjusting Motion for the Declination Axis: Red Button

SkyStopper is designed to accurately follow the stars. Tracking faster or slower than the stars causes the stars to appear to move in the eyepiece view, in the Right Ascension direction.

The Guide Actuator enables SkyStopper to make the stars move in the orthogonal direction, enabling you to compensate for sag or refraction, or to keep a photo centered. The Guide Actuator can move the south end of the telescope laterally or vertically.

Depending on where your telescope is pointing, a pure vertical motion of the telescope leg may be in a similar direction as Right Ascension.

For example, when looking east, raising the telescope's south support leg by a few mm simply rotates the field of view by a tiny fraction of a degree. Therefore SkyStopper allows the declination axis to be selectable between lateral and vertical effects.

To adjust the mix of vertical and lateral motion for the declination axis during guided operation:

1. Enter a number between 0-100.
2. Press **Red** to select a mix of vertical and lateral motion (percent lateral).

Declination Guidance Example

The platform enables changing the mix of vertical and horizontal travel that happens when declination guidance signals are received.

If the amount of vertical and lateral motion is known:

1. Enter the percentage lateral factor on the numeric keys.
2. Press **Red**.

If the amount of vertical and lateral motion is unknown, the recommended method of setting declination guidance is to use the eyepiece view.

If the amount of vertical and lateral motion is known:

1. Focus on a star in the direction you intend to photograph.
2. Press **Pause**.

The star will drift rapidly eastward as the earth rotates.

3. Press **Yellow** to restart tracking and compensate for any lost time.

Now you must select the correct lateral factor so that **PR+** moves the telescope at right angles to the direction you observed when paused.

4. Press **PR+** and observe the direction of stellar motion.
5. Press the number keys, 0-100 then enter (<-PR).
6. Press **Red**.
7. Press **PR+** again to see which way the star moves now.

When you are satisfied with the direction, you are ready to begin guiding.

For more information on Auto-guiding, see "[Astro-Photography With Autoguiding](#)" on page 64.

5.1.8 Stopping All Motion

Although this procedure requires that you press the red **Power** button, it does not power down SkyStopper. The only way to power down SkyStopper is to disconnect the power cable.

To stop all motion:

- Press the red **Power** button on the remote controller.

Use this procedure if:

- The platform starts moving while the L-blocks are still in place
- Something is blocking the limit switch and the motor is struggling

- To terminate normal actions, such as slewing or finding the Index position

Note: You must successfully index SkyStopper once in each power cycle, before it will track celestial objects or seek specific positions.

5.1.9 Pausing the Motors: Pause Button

To pause the motors:

- Press **Pause**

The motors immediately pause in their current location.

5.1.10 Resuming Tracking

Use either method to resume tracking:

- Press **Yellow** to resume tracking and compensate for lost time
- Press **OK** to resume tracking from the current position without compensating for lost time.

5.1.11 Undo Action: Yellow Button

Use this procedure to undo actions including:

- Power cycle
- Seek position request
- Centering request
- Pause

When you undo any of these actions, SkyStopper compensates for lost time, resuming its previous tracking activity where it would have been, had the action not been taken.

Pressing **OK** for greater than ten seconds returns SkyStopper to the Center position. If you invoke the Seek procedure by accident, you can undo it. The Undo Seek procedure compensates for the earth's rotation during the time interval from before the Seek procedure to the end of the Undo Seek procedure.

To undo any of the listed actions:

- Press **Yellow**.

Once the platform returns to its previous position, it immediately resumes tracking.

5.1.12 Rewinding To The Start Position

When the platform reaches the End position, it will beep for five seconds, and then stop.

To rewind to the Start position:

1. Press **Pause**, or wait until the platform enters the Pause state.
2. Press **OK** for one second.

When the platform is fully rewound to the Start position, it stops and waits for another command.

Note: If you use digital setting circles, this is the optimum time to target a new object.

Rewinding To The Center Position

To move to the Center position during rewind:

- During rewind, press **OK** for one second.

Pressing **OK** during rewind changes the SkyStopper destination to the Center position. When SkyStopper arrives at the Center position, it stops and waits for another command.

During rewind, the main controller displays its target position:

- Start: Short L
- Middle: _
- End: Backwards short L

When you change the SkyStopper destination during rewind, it also provides an audio signal that corresponds to the new destination.

5.2 Additional Commands

Now that the unit is set up and running, you can run additional commands, available from the remote controller.

5.2.1 Seek Specific Locations While Not Tracking

To seek specific locations while not tracking:

1. Activate the slew controls.
2. Activate the fine adjustment controls as required:
Double arrows (Up or Down) move single steps on the most recently slewed axis.
3. Type a number.
4. Press **<-PR**, then Double (Up or Down) Arrows to repeatedly move that many steps.
One turn of the main motor is equal to 3575 steps and advances the unit by approximately 5 arc minutes.

5.2.2 Seek an Absolute Position

To seek an absolute position:

1. Type the step number (generally, 0 to 425000).
2. Press **TVRADIO**.
3. Press **<-PR**.
4. Press **Triangle+**.

5.2.3 Operate the Lateral Actuators

Use any one of the following methods:

- Press **FAV** and **MENU** to interactively aim the telescope.
- For larger amounts of motion, enter a number between 0 - 50000 on the numeric keypad, press **<-PR**, and press **FAV** or **MENU** again.
- For an absolute position, enter a negative number between 0 - -20000 and press **FAV** or **MENU** again.
- Press and hold **PAUSE** to initiate indexing of the actuator.

SkyStopper will not respond to the other commands until it has found the Index position. Until index has been found, using the fine guidance buttons (**MENU**, **INFO**, **FAV**, and **EXIT**) is rejected.

5.2.4 Operate the Vertical Actuators

Use any one of the following methods:

- Press **INFO** and **EXIT** to interactively aim the telescope.

- For larger amounts of motion, enter a number between 0 - 50000 on the numeric keypad, press **<-PR**, and press **INFO** or **EXIT** again.
- For an absolute position, enter a negative number between 0 - -20000 and press **FAV** or **MENU** again.
- Press and hold **PAUSE** to initiate indexing of the actuator.

SkyStopper will not respond to the other commands until it has found the Index position. Until index has been found, using the fine guidance buttons (**MENU**, **INFO**, **FAV**, and **EXIT**) is rejected.

5.2.5 Seek Specified Locations

Sky Stopper understands a number of specified locations, including:

- Index
- Start
- Middle
- End

To seek specified locations:

1. If SkyStopper is tracking celestial objects, press **Pause**.
2. Press **OK** for a two seconds (medium press) to initiate rewinding to the Start position.
If the platform is already at the Start position, a medium press sends it to the Center position.
3. Press the **Yellow** button to undo this motion and return to the previous location.
Note: This location depends on the state before the most recent motion.

To change the target destination, see [“Seeking the Start/Center/End Positions” on page 53](#).

5.2.6 Center the View While Tracking

SkyStopper provides multiple methods to center the view while tracking:

- Fine adjustments operate at approximately 1/4 sidereal rate
 - Press **Triangle+** and **Triangle-** for fine adjustments in either direction
- Coarse adjustments operate at approximately five times sidereal rate
 - Press **SAT** to toggle the coarse adjustment mode on and off

To adjust the view while tracking:

1. Press **OK** for less than one second (Short Press) to Pause.
2. Press the slew buttons as required.
3. Press **OK** again for less than one second to begin tracking.

5.2.7 Seek the Index Position

To seek the index position:

1. If SkyStopper is tracking, press **Pause** or **OK** for less than one second (short press) to Pause.
2. Press and hold **OK** until SkyStopper begins moving, showing three horizontal lines on the display.

3. When SkyStopper finds the Index position, it:
 - Stops moving
 - Clears the display
 - Begins (or resumes) tracking

5.2.8 Change the Audio Alerts

SkyStopper has eight levels of mute. Your selected mute level does not persist across a power-cycle. For more information on the muting levels available, see “[Speaker Muting Levels](#)” on page 42.

To change the audio alerts:

- Press **MUTE** (at the upper right of the remote controller) to reduce the range of conditions for which the unit beeps.

5.2.9 Adjust the Tracking Rate

When the tracking rate is changed, the main controller beeps to indicate a new tracking speed and displays a symbol indicating the tracking rate. There are four available rates:

- Star
- Sun
- Moon
- Half-solar

To adjust the tracking rate:

1. Press **OK** for one second while tracking.
2. Release **OK**.

Fine-Tune the Moon Rate

To fine-tune the moon rate:

1. Confirm that SkyStopper is currently tracking at the Moon Rate (the main controller will display ‘c’).
2. Locate and center the lunar crater of interest.
3. Press the **Green** button.
4. Press **Triangle+** or **Triangle-** to adjust the centering.
5. After approximately one minute, when the crater is centered, press the **Green** button again.

The platform will now track at the adjusted rate.

Moon rate is remembered for the rest of the evening. You can return to moon rate and the adjustments will still apply regardless of pole tuning and other adjustments you make in other rates (sidereal solar etc)

Cancel the Moon Rate

To cancel the moon rate adjustment while tracking at moon rate:

- Press and hold the **Blue** button for five seconds.

The main controller beeps to acknowledge the Cancel procedure.

When tracking at the moon rate, this Cancel procedure does not clear pole-tune settings. For more information, see [“Compensate for Polar Misalignment”](#) on page 62.

5.2.10 Compensate for Polar Misalignment

This procedure only works when tracking at Star, Sun, or Half-solar rates.

To compensate for polar misalignment:

1. Center a star.
2. Press the **Green** button.
3. Press any combination of **Triangle+**, **Triangle-**, **FAV**, **EXIT**, **MENU**, or **INFO**.
4. Press either **PR+** or **PR-** to re-center the star.
5. Press **Green** again.

SkyStopper now make the adjustments you entered continually. This procedure helps deliver crisp, unblurred Astro-photography images.

SkyStopper calculates compound guide commands, freeing the guide controller to only compensate for periodic errors.

To cancel polar misalignment (pole tune) settings:

1. Verify that the platform is not tracking at Moon Rate.
2. Press and hold the **Blue** button for five seconds.
3. The main controller beeps to acknowledge the Cancel procedure.

5.2.11 Measuring Misalignment

To measure misalignment:

1. Follow the pole tuning procedure provided in [“Compensate for Polar Misalignment”](#) on page 62.
2. Press the **Blue** button.

The main controller displays its current status.

3. Press **Blue**.
4. Note the number displayed on the main controller.

This number indicates the number of arc-minutes SkyStopper is tracking, right of the pole. If the number is negative, the SkyStopper axis is left of the celestial pole.

The number is shown with two decimals of precision implied. For example, 5625 means 56.25 arc-minutes of adjustment is required.

5. Adjust the SkyStopper position by moving it a computed number of inches per arc-minute. For a typical platform this distance is approximately 1/100 of an inch per arcminute.
6. Once the adjustment is made,

7. Press and hold **Blue** for five seconds.

The main controller displays the number of arc-minutes of misalignment from the north pole, east of the polar alignment.

This procedure cancels the gradual guidance which was initiated with **Green**, as it is no longer required.

5.3 Astro-Photography With Autoguiding

To calibrate the main controller for autoguiding during astro-photography sessions:

1. Adjust SkyStopper motion to compensate for the declination axis, as indicated in [“Adjusting Motion for the Declination Axis: Red Button”](#) on page 55.
2. Connect your guide interface to the ST-4 connector on the main controller.
Note: This is the only connection to the main controller that can be made while it is powered up.
3. Launch the guiding software and allow it to calibrate and guide your astro-photography session.



6

Troubleshooting

6.1 Drivetrain

Do not force the motion of the main motor by manually turning the drive rod, as this can damage the gear train.

Do not activate the platform to seek zero unless the linkage is attached, the L blocks are clear, and there is sufficient room for the platform to actually move.

6.1.1 Carriage Jamming

If the carriage jams for an extended period of time, it is possible to sustain damage to either or both the motor and the main controller. To alert you of malfunction, the main controller beeps many times before either component sustains damage.

If the carriage jams:

- Ensure sufficient clearance of all internal components for the drivetrain assembly to move the platform throughout its entire range of motion.

6.1.2 Drivetrain In Rewind

The motor rewinds the platform 60 times faster than normal tracking. This builds considerable momentum in the spinning motor which can damage the gears if the drive shaft is suddenly stopped.

If you detect that the linkage is not attached, or physical impediments to the travel of the platform, either:

- Press the red **Cancel** button
- Remove the main power cord

6.2 Display the Position of Actuator Motors

To show status during calibration:

- Press **Blue** > **3** to display the current position of the vertical actuators
- Press **Blue** > **4** to display the current position of the lateral actuators

6.3 Operations

6.3.1 Platform Stops Moving

If SkyStopper beeps and stops moving, check:

- Physical impediment to motion
- Telescope has shifted and is unbalanced
- Power supply is exhausted. For best operations, re-charge power source to 12 VDC.

6.3.2 Main Controller Does Not Respond to Actuator Commands

There are numerous possible reasons SkyStopper may not respond to commands as expected.

First Check:

- The telescope is not too heavy and overloading SkyStopper
Reference the weight on your build sheet and compare that to the current physical weight of your telescope.
- The drivetrain is able to move freely, with no physical impediments
- Telescope foot is centered in the actuator cup

Single-Axis SkyStopper

Single-axis SkyStoppers do not include horizontal or vertical actuators, therefore, pressing FAV, MENU, EXIT, or INFO does not move the platform.

It is possible to re-assign these buttons to other functions, such as moon and solar rates. For more information, contact the factory at smrg@cogeco.ca

Actuator Not Centered At Last Power Down

Press **Pause** for five seconds to center the actuator.

This process can take up to three minutes. During this time, telescope aiming accuracy will be impacted by up to 2 degrees. When the process completes, the main controller beep and the buttons will work as expected.

Remote Infrared Receiver is Not Receiving

If the remote infrared receiver works when pointing the remote controller directly at the main controller:

- Confirm the cable connections for the remote infrared receiver and extension cable (if used)
- Confirm the remote infrared receiver is aimed towards your observing position
- Confirm that the remote infrared receiver connector has not been damaged by erroneously plugging the speaker in when powered up

6.4 Audio / Muting

6.4.1 No Sound is Audible

If SkyStopper does not provide any audio signals, check the conditions in this topic.

Mute Level Set Too High

Pressing **Mute** a few times until the mute level cycles back to zero. Watching the main controller display for mute levels.

Speaker is Not Connected

Confirm the connection between the speaker and the connector on the main controller with the white ring, closest to the ST-4 connector.

Erroneously plugging the speaker cable into the infrared remote receiver connector causes a protection device within the controller to burn out and a replacement is required to use the infrared remote controller.

Speaker is Burned Out

Contact the manufacturer at smrg@cogeco.ca for replacement speakers. Any standard computer speaker can be used.

6.5 Tracking

6.5.1 Stellar Tracking Rate Incorrect

If the stellar tracking rate is incorrect, confirm that these conditions are operating correctly:

- SkyStopper is powered up and main controller has finished initializing
- Tracking in Sidereal Rate
- SkyStopper was accurately levelled and aimed approximately northwards
- No physical objects are impeding the forward motion of the platform
- SkyStopper has not reached the End position and is waiting for a rewind command

6.6 Latitude

If you want to use SkyStopper at a different latitude than the original design latitude, ensure the altitude of the axis is correct for your current location. For more information, see [“Using SkyStopper Away From Home” on page 27](#).

The leveling process is designed to be quick and easy, so the bubble level would not normally ever need to be adjusted. If you expect to be observing Away From Home for many setups (10 or more), you can optionally recalibrate the bubble level to the current location. The bubble level gimbals might not have the range to bring it to level far from home.

Note: If you recalibrate the bubble level to the current latitude, you will have to perform the adjustment procedure each time at home until you recalibrate again for Home. Consequently, recalibrate the bubble level only when you expect to be Away From Home for a significant period of time such that adjusting the apex foot after leveling outweighs the effort to recalibrate the gimbals twice.

6.6.1 Recalibrating the Bubble Level Away From Home

If you expect to be observing Away From Home for a period of time, you can recalibrate the bubble level to the current location.

Note: If you recalibrate the bubble level to the current latitude, you must recalibrate again for Home. Consequently, recalibrate the bubble level only when you expect to be Away From Home for a period of time.

The gimbals on the bubble level do not need to be recalibrated if you only observe Away From Home occasionally. Typically, you would only recalibrate the bubble level if adjusting the foot by the computed number of turns becomes tiresome.

To recalibrate the bubble level to the current Away From Home latitude:

1. Level the base at the current latitude as shown in [“Leveling Away From Home” on page 27](#).
2. Adjust the gimbals until the bubble is centered in the bubble level.

SkyStopper is now calibrated for the current Away From Home latitude. To setup the platform again in this latitude, level the platform as shown in the bubble level and the altitude of the SkyStopper axis will match that of the celestial pole.

6.6.2 Recalibrating the Bubble Level At Home

If you subsequently return Home after recalibrating Away From Home, you must reset your calibration to Home.

Note: Use this procedure only if:

- The platform has been calibrated Away From Home
- The bubble level calibration has been lost
- The bubble level is being replaced

To reset your calibration to Home:

1. Level the platform as shown in [“Leveling At Home” on page 26](#).

2. Adjust the apex foot the number of turns computed in [“Compensating For Being Away From Home”](#) on [page 27](#).
3. Recalibrate the bubble level as shown in [“Recalibrating the Bubble Level Away From Home”](#) on [page 71](#).

6.7 Telescope Issues

6.7.1 Telescope is Rotating on its Own Axis

If your telescope is rotating on its own axis, due to being tilted by SkyStopper, check these conditions:

- Telescope counterweights may need to be adjusted

Counterweights for items at the eyepiece should be located diagonally opposite on the mirror box, to avoid producing a torque at different altitudes.

- Rotation lock may be required

Adding a weight to the base will compensate for rotational asymmetry of the base material, making it heavy on one side.

Caution: Do not exceed the telescope weight listed on your Build Sheet.

6.8 Complete Setup

The Complete Setup procedure is included for diagnostic purposes and completeness. It should be used only in rare circumstances where the Quick Setup procedure does not provide accurate tracking.

These circumstances could include:

- The bubble level has lost calibration
- You are observing from a different latitude than the bubble level is calibrated for and would like to recalibrate to avoid manual compensation at every setup

To setup SkyStopper for observation:

1. Place the platform on the ground, with the base pointing north and the apex pointing south, as shown in [Figure 3 on page 22](#).
2. Make all electrical connections to the main controller, including:
 - Optional remote receiver
For more information, see [“Using the Optional Remote Infrared Receiver” on page 41](#)
 - Optional speaker
For more information, see [“Using the Optional Speaker” on page 42](#)
 - Main power
Always connect main power last, following the speaker and IR receiver.
3. Level the platform using the knobs on the leveling feet, as indicated by the bubble level.
The axis of the platform will now match the altitude of the celestial pole.
4. Lock the platform in the center position, by supporting it with the supplied wooden L-blocks.
5. Place the telescope on the platform, locking the telescope's feet to the guides.
6. Remove the L-blocks.
7. Ensure that the telescope is stable and well-balanced.

SkyStopper is designed to have a small amount of built-in stability. The axis is designed to sit slightly above the center of gravity of the entire platform and telescope, which moves.

Due to the main controller being mounted on one side of the platform, your telescope will not be perfectly vertical when it seeks toward the center. This is a normal condition.

However, the telescope must not accelerate towards the outer limits, where it could tip due to gained momentum.

To confirm that the required amount of stability is present:

- With the linkage disconnected, confirm that the telescope does not tilt away from center.
 - If the telescope tends to lean outwards, move it towards the north (wide) end of the platform to attain better stability before proceeding.
 - In this case, mark the new position where the telescope either seeks the center slightly, or can be positioned at any angle without moving laterally, and use this position to ensure stability.
8. Attach the magnetic linkage, as shown in [“Attaching and Detaching the Magnetic Linkage” on page 15](#).

6.9 Error Codes

SkyStopper acknowledges error conditions with unique error announcements, as shown in the table.

Most error announcements mean either try the action again, or do not try that action again. Some error conditions must be physically corrected or resolved. These errors will repeat until the underlying condition is corrected.

Common Error Conditions

- Code 9: Platform jammed or overloaded
 Check for items jamming the carriage
 Reduce the total weight of all equipment loaded onto the platform
 Confirm the total weight of all equipment loaded onto the platform
- Code F: IR input received garbled
 The remote is not pointing directly at the pick-up.

Display	Code Number	Tone	Description
0	Code 32	Middle tone is low	Green was pressed (for fine tuning of the tracking rate) while SkyStopper is not tracking. The rate can only be tuned when SkyStopper is tracking.
2.	Code 18	Middle tone is medium	Indicates garbled Infra-Red input was received. Reposition the remote and enter the command again.
3	Code 35	Middle tone is low	Internal software error detected while accessing stored settings. Contact Technical Support.
3	Code 3	Middle tone is very high	Occurs when a command to seek Center or End is given before the platform has been initialized. Use a short OK press to force the platform to find the limit switch. Once the limit switch has been located, all Seek commands will work.
3.	Code 19	Middle tone is medium	Indicates that the remote button is being held, but the main controller did not receive the initial part of the IR sequence, and therefore does not know which button was pressed. Ensure the remote controller is pointed directly at the receiver, and enter the command again. The Infra-Red remote sends a special code for each button. When the button is held, it sends a <i>same button again</i> repeat code, 10 times per second. The same repeat code is used for all buttons. SkyStopper needs to know which button is being repeated at the beginning of the command.

Display	Code Number	Tone	Description
4	Code 36	Middle tone is low	Internal software error detected while accessing stored settings. Contact Technical Support.
4	Code 4	Middle tone is very high	The platform attempted to sense the limit switch, but it was already at the limit. The platform could not advance forward to get clear of the limit switch, within the timeout period.
4.	Code 20	Middle tone is medium	<p>Triple-axis error only.</p> <p>Indicates that an attempt to control the guide actuator was initiated, but the guide has not been centered since power-up and was not left in a centered position when powered off.</p> <p>Press and hold 1 to release the lock, then while viewing the guide's motion, center it, and hold 1 again to lock in the correct center position.</p>
5	Code 37	Middle tone is low	Internal software error detected while accessing stored settings. Contact Technical Support.
5.	Code 21	Middle tone is medium	<p>Triple-axis error only.</p> <p>Indicates that an attempt to control the guide actuator was initiated, but the guide has not been centered since power-up and was not left in a centered position when powered off.</p> <p>Press and hold 1 to release the lock, then while viewing the guide's motion, center it, and hold 1 again to lock in the correct center position.</p>
6.	Code 22	Middle tone is medium, same as code 21	<p>Triple-axis error only.</p> <p>Indicates that an attempt to control the guide actuator was initiated, but the guide has not been centered since power-up and was not left in a centered position when powered off.</p> <p>Press and hold 1 to release the lock, then while viewing the guide's motion, center it, and hold 1 again to lock in the correct center position.</p>
7.	Code 23	middle tone is medium, same as code 21	<p>Triple-axis error only.</p> <p>Indicates that an attempt to control the guide actuator was initiated, but the guide has not been centered since power-up and was not left in a centered position when powered off.</p> <p>Press and hold 1 to release the lock, then while viewing the guide's motion, center it, and hold 1 again to lock in the correct center position.</p>

Display	Code Number	Tone	Description
8.	Code 24	Middle tone is medium	<p>The Triangle+ or Triangle- button was used with a previously entered numeric argument. An attempt was made to slew the platform position beyond the range of permitted travel.</p> <p>The command was ignored.</p>
9	Code 41	Intermediate tone lower than first tone	<p>Indicates that the platform has detected an overload or a jam.</p> <p>The motor is not responding to the main controller's command to move. The main controller removes all power from the motor for 2 seconds and then tries again. This is to prevent possible overheating of the motor which might happen if the power is not removed.</p> <p>Determine the cause of the jam and correct it.</p> <p>If the platform has rewound past 0 and missed the limit switch sensor, it will jam and produce this code.</p> <p>This can only happen if the platform is operated without sufficient weight on it and it came off the bearings while rewinding.</p> <p>Remove the linkage, manually spin the carriage several turns to get it back in range, re-connect the linkage, put some weight on the platform, and rewind it again.</p> <p>If this error persists, check the cables and call Technical Support if damaged.</p>
9.	Code 25	Middle tone is medium	<p>The Triangle+ or Triangle- button was used with a previously entered numeric argument. An attempt was made to slew the platform position beyond the range of permitted travel.</p> <p>The command was ignored.</p>
A	Code 10	Middle tone is high	<p>Indicates that the limit switch is still detected after the motor has moved far enough to be clear of it.</p> <p>Try initializing one more time (very long OK press).</p> <p>If this fails, inspect and determine if:</p> <ul style="list-style-type: none"> • The platform is rewound past the End position • The cables are connected properly • Nothing is jammed in the limit sensor

Display	Code Number	Tone	Description
A	Code 42	Middle tone is lower than the first tone	The software has detected that the programmed settings for the Tracking Tables are corrupt. Contact Technical Support.
b	Code 11	Middle tone is high	An unsuccessful UNDO command was attempted. Indicates that UNDO is not available, based on the current state and position of the platform.
b	Code 43	Middle tone is very low	The guide actuator was not left in a known state at power-off. See Error Code 21 for more information.
c	Code 12	Middle tone is high	Undo is not supported for certain situations. This was a request to undo the initialization.
c.	Code 28	Middle tone is medium	Similar to Error Code 24, but the request was made to adjust the declination via the guide actuator and was out of range.
d	Code 45	Middle tone very low	An attempt to adjust the platform was made, while the limit switch is sensed. The command was ignored. See Error Code 10 for more information.
d.	Code 29	Middle tone is medium	Similar to Error Code 24, but the request was made to adjust the declination via the guide actuator and was out of range.
e.	Code 30	Middle tone is medium	An attempt to reprogram the Infra-Red remote codes was received but the protocol has not been followed. The command is ignored. This is an advanced function for use only when the original remote control has been lost. Contact Technical Support for details of the process if the remote is lost, to get another or to reprogram the SkyStopper control to accept codes from a new remote you already have.
F	Code 47	Middle tone matches last tone	Contact Technical Support.
F.	Code 31	Middle tone is medium	An IR input was sensed which cannot be found in the table. The input signal received was not understood. Align the receiver and the remote controller, for better communication.
	Code 1	No sound	Factory use only
	Code 14	No sound	Factory test mode only

Display	Code Number	Tone	Description
	Code 2	No sound	Factory use only
	Code 7	Middle tone is very high	<p>The platform failed to end up at its destination within the required time.</p> <p>Ensure all wiring is secure and connectors fully and correctly engaged.</p> <p>If error cannot be resolved, contact Technical Support.</p>
	Code 9	Middle tone is very high	<p>Indicates that a command to seek Start, Middle, or End was issued but the platform has not been initialized in this power cycle.</p> <ol style="list-style-type: none"> 1. Ensure the platform is not obstructed 2. Confirm the linkage is properly installed 3. Press a short tap on OK to initialize.



7

Glossary

7.1 Glossary Terms

Term	Abbreviation	Description
right ascension	RA	This is the angle in the sky measured from the vernal equinox (the amount to the west) RA is generally measured in hours, and 24 hours represents the full circle
declination	dec	The angle above or below the celestial equator
celestial pole		Near the north star, the projection of the earth's axis of rotation into the sky
guiding		Using a computer to command fine adjustments to the tracking speed and aiming of a telescope, to render crisp time-exposure images. The ST-4 connector accepts four guide signals: <ul style="list-style-type: none"> • RA+ • RA- • Dec+ • Dec- {do we need a pin-out reference for this, or does it comply with a standard ??} Simulating the guide inputs: The buttons on the remote controller connect to the control system, emulating computer command.
Center of Gravity	CoG	Although we talk about the Center of Gravity, it is relative to the Center of Mass. In physics, the center of mass of a distribution of mass in space is the unique point where the weighted relative position of the distributed mass sums to zero. The distribution of mass is balanced around the center of mass and the average of the weighted position coordinates of the distributed mass defines its coordinates. Calculations in mechanics are often simplified when formulated with respect to the center of mass.
arc-minutes	MOA	A minute of arc, arcminute, or minute arc (MOA), is a unit of angular measurement equal to one sixtieth (1/60) of one degree. In turn, a second of arc or arcsecond is one sixtieth (1/60) of one arcminute. Because one degree is defined as one three hundred and sixtieth (1/360) of a rotation, one minute of arc is 1/21,600 of a rotation, which also equals pi/10,800 radians.
base		
platform		
linkage		
carriage		
apex		

Term	Abbreviation	Description
limit switch		
index position		
actuator		
zenith		<p>The point on the sky directly above the observer.</p> <p>Conventional Dobsonian mounts have difficulty tracking near the zenith, because significant combinations of rotation and tilt are needed to track a star a small angular distance in the sky as the earth turns.</p> <p>A telescope on the SkyStopper can track through the zenith without any special considerations.</p>
meridian		<p>Calculated trajectory through the sky, between the north pole and the southern horizon, due south of the observer.</p> <p>In the southern hemisphere, this trajectory extends from the south pole to the northern horizon, due north of the observer.</p> <p>By definition, the meridian passes through the zenith.</p>
rewind		<p>Causes the motor to position the platform so the telescope is tilted towards the East and ready for another tracking session.</p>
centering		<p>Position of the platform when the telescope is level at least in the east-west direction.</p>
stability		<p>Measure of telescope balance when mounted on the platform.</p> <p>Stability is realized when the telescope and platform tend to seek the center.</p>
tip resistance		<p>Measure of how hard it is to tip the scope when already tilted at the end of travel.</p>

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Ekasilicon Technology Ltd
3384 Guildwood Drive
Burlington ON
Canada
L7N 1L5
905 333 6472

www.skystopper.ca